EFFECT OF COMPRESSED NATURAL GAS ON PERFORMANCE AND EMISSION OF A 4-STROKE SPARK IGNITION ENGINE

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ABSTRACT

This thesis deals with experimental study of a four-stroke spark ignition engine. The objective of this thesis is to evaluate the performance and emission characteristics of the engine while using conventional fuel, gasoline and alternative fuel, compressed natural gas (CNG). The engine operated under a steady state condition at wide-open throttle condition. The performance and emissions test was performed with various constant loads at different speed within the range of 1500 rpm to 4000 rpm with 500 rpm interval. The first experiment is executed by using gasoline and followed by CNG. The engine performance and emissions such as air-fuel ratio, torque, brake power, brake specific fuel consumption, efficiency, the concentration of CO, CO_2, HC, and NO_x of gasoline and CNG were measured. The results demonstrated that the potential of reducing emissions while applying CNG as fuel is obvious. However the performance of CNG is reduced as the brake power of engine decrease around 25% compare to gasoline engine. During operate with CNG the engine emissions of CO, CO_2 and HC shows a significant reduction but the NO_x emission is highly increased compare to gasoline. The results and analysis will be useful for the development of dedicated gas engine in the near future.

ABSTRAK

Tesis ini membentangkan keputusan ujikaji enjin nyalaan bunga api bagi menilai prestasi dan ciri-ciri emisi apabila menggunakan bahan api gasolin dan gas asli termampat (CNG). Bagi menilai prestasi engine, operasi dilakukan dengan kelajuan enjin antara 1500 ppm hingga 4000 ppm, di bawah keadaan mantap dengan pendikit terbuka luas (wide-open throttle). Ujian emisi dijalankan dengan menggunakan beban tetap yang berbeza pada setiap kelajuan. Prestasi dan keluaran engin seperti nisbah udara-bahan api, daya kilas, kuasa brek, penggunaan bahan api tentu brek CO, CO_2, HC dan NO_x dari CNG diukur dan dibandingkan dengan bahan api gasolin. Keputusan kajian menunjukkan CNG sangat berupaya mengurangkan keluaran berbanding dengan gasolin. Walau bagaimana pun, prestasi CNG berkurangan, di mana kuasa brek menurun sehinga 25% pada berbanding dengan gasolin. Semasa beroperasi dengan CNG keluaran engine seperti CO, CO_2 dan HC sangat berkurangan tetapi keluaran NOx meningkat dengan begitu tinggi berbanding dengan gasolin. Keputusan dan analisa yang dibuat sangat berguna untuk kajian lanjut bagi tujuan pembangunan enjin gas pada masa depan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

B	Bore
C_F	Correction factor
C_d	Coefficient of drag
L	Stroke
m_a	Air flow rate
$\dot{m}_f$	Fuel flow rate
$\dot{m}_a$	Air flow rate
ΔP	Pressure diffrent
$P_{i,m}$	Measured indicated power
$P_{s,\,d}$	Standard dry-air absolute pressure
P_m	Measured ambient-air absolute pressure
$P_{i,\,s}$	Standard indicated power
P_b	Brake power
P_f	Measured friction power
$P_{i,\,g}$	Indicated gross power
$P_{b,\,m}$	Measured Brake power
P_{atm}	Atmosphere pressure
P_i	Measured indicated power
Q_{LHV}	Low heating value

$\bar{S}_p$	Mean piston speed
T_s	Standard ambient temperature
T_{amb}	Temperature during experiment
V_d	Displaced volume
ρ_{air}	Air density
t_f	Time of fuel consumption in second
η_{bth}	brake thermal efficiency
η_{bth}	Mechanical efficiency
η_v	Volumetric efficiency

LIST OF ABBREVIATIONS

AFR	Air-fuel ratio
BMEP	brake mean effective pressure
BSFC	Brake specific fuel consumption
BDC	Botton dead centre
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
DOHC	Double over-head cam
EGR	Exhaust gas recirculation
FMEP	Friction mean effective pressure
HC	Hydrocarbom
LPG	Liquified Petroleum Gas
PMEP	Pump mean effective pressure
SULEV	Super ultra low emissions vehicle
sfc	Specific fuel consumption
SI	Spark ignition
TDC	Top dead centre
TWC	Three-way catalytic converter
ULEV	Ultra low emission vehicle
WOT	Wide-open throttle

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Engineering (Automotive).

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Date : 14 NOVEMBER 2009

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degrees.

Signature

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Date: : 14 NOVEMBER 2009

Dedicated to my beloved family and friends

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES